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Heidelberg University Hospital

Heidelberger Ion Beam Therapy Center

HIT

Heidelberg Ion Beam Therapy Center

Contents

Dear readers,
This brochure has been prepared to provide you with insights into the current technical and medical status of the Heidelberg Ion Beam Therapy Center (HIT). HIT officially opened on November 2, 2009, and the first patient underwent therapy here two weeks later, on November 15th. In October 2012 HIT starts operating the worldwide first heavy ion therapy facility with a 360° rotating beam delivery system (gantry). Up to now, after nearly three years, the number of patients who have received treatment at HIT has exceeded 1.000. At full capacity, 750 patients per year will be able to undergo therapy.

The pioneering efforts of doctors, scientists and technical personnel, the perseverance of everyone involved in the challenging start-up phase and the entrepreneurial courage of Heidelberg University Hospital and its partners have borne fruit, to the benefit of both the patients and scientific progress. The center is the first treatment facility of its kind in Europe where patients with malignant tumors can be treated with both heavy ions and protons. It offers technical equipment unparalleled in any other institution in the world.

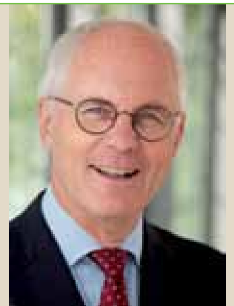
A highly innovative project like HIT requires reliable partners who bring generous yet prudent support. Besides the scientific, technical and medical partners, these are in particular the health insurance companies who allow their members access to a new oncological treatment form through their participation in clinical studies.

In the past three years, in addition to the clinical practice established at HIT, thanks to the efforts of German Cancer Aid, the NCT, or National Center for Tumor Diseases was built next door within a very short period. The NCT is a joint project with the German Cancer Research Center (DKFZ). Treatment at HIT is now an integral part of a truly interdisciplinary range of therapy.

We wish to express our sincere thanks to everyone who is involved in medical care and research on a daily basis at HIT or who support HIT with their cooperation.

I. Gürkan

Irmtraut Gürkan
Administrative Director
Heidelberg University Hospital



Guido Adler

Prof. Guido Adler
Medical Director
Heidelberg University Hospital

Introductory messages

Prof. Jürgen Debus
Medical Director of the Department of Radiation Oncology and Radiotherapy at Heidelberg University Hospital, Scientific and Medical Director of the Heidelberg Ion Beam Therapy Center (HIT)

Prof. Thomas Haberer
Scientific and Technical Director of the Heidelberg Ion Beam Therapy Center (HIT)

Dear readers,
The discovery of x-rays over 100 years ago constituted a medical milestone. Physicist Wilhelm Conrad Röntgen immediately recognized the opportunities unleashed by these "new beams." What then seemed a sensational novelty has become a standard part of everyday medical routine today. X-rays are not only used in diagnostics, but are also employed to treat malignant diseases. Over sixty percent of cancer patients undergo radiation therapy today, either alone or in combination with surgery or chemotherapy. With protons and heavy ions, more "new beams" have entered the field of tumor treatment. While they promise even higher precision and efficacy, they also require substantially more sophisticated equipment.

A team of employees from the GSI Helmholtz Center for Heavy Ion Research, the German Cancer Research Center (DKFZ), the Helmholtz Center Dresden-Rossendorf (HZDR) and Heidelberg University Hospital have mastered this challenge. In a pilot project between 1997 and 2008, over 400 patients were successfully treated with ion beams and experience was gathered for setting up a clinical facility in Heidelberg.

Since 2009, patients have undergone radiation therapy at the Heidelberg Ion Beam Therapy Center (HIT). This radiation therapy is always conducted as part of an overall cancer treatment strategy. HIT's connection to the National Center for Tumor Diseases (NCT) in Heidelberg offers a wide range of treatment options. As a result, each patient can receive treatment that is individually tailored to his or her individual needs and is coordinated with experts from various medical disciplines. The treatment is complemented by a wide variety of psychosocial services.

HIT is an outstanding example of the successful cooperation of numerous experts from various disciplines, such as physics, medicine, information technology, biology and architecture, who have created something completely unique. Our technology has allowed us to achieve higher cure rates for many types of cancer. However, the scientists are constantly working to improve treatment results. With this informative brochure, we wish to help you learn more about HIT and hope that you enjoy reading it.

Heidelberg, October 2012

Jürgen Debus
Prof. Jürgen Debus

Thomas Haberer
Prof. Thomas Haberer

Physicians have used radiation to destroy malignant tumors for many years. In conventional radiation therapy, they work with x-rays and gamma rays consisting of tiny light particles, known as photons. Photon radiation is the most common type of radiation used in cancer treatment today. At the Heidelberg Ion Beam Therapy Center (HIT), ion radiation is used. It is also called particle radiation, because it consists of highly-accelerated, charged atomic nuclei.

These include protons and heavy ions.

> Protons are the positively charged nuclei of hydrogen atoms.

> Heavy ions are the positively charged nuclei of atoms with a larger mass. They are substantially heavier than protons.

> The heavy ions used at HIT are carbon, oxygen and helium ions.

Ion radiation reaches even deep-seated tumors.

Ion radiation has a defined range that can be adjusted with millimeter precision. At HIT, the charged particles are accelerated to up to 75% of the speed of light and are then directed at the tumor with pinpoint accuracy. Depending on their momentum, the ions can penetrate up to 30 centimeters into the tissue. Ion beams therefore allow high doses to be used at great depth and at the same time sparing the healthy tissue. This represents a great advantage of ion beams over photon or x-ray radiation, which is most effective at a tissue depth of approx. three centimeters. At greater depths, the dose decreases, as the beam is continuously attenuated while passing through the tissue. In addition, healthy tissue lateral to the tumor is affected, and tumors located deep in the body do not receive a radiation dose high enough to destroy them. These disadvantages can often be mitigated with modern radiation techniques – but not always.

Highly accelerated atomic nuclei

Protons and heavy ions are used instead of photons

Maximum dose in the Bragg peak

Ion radiation is more accurate.
Due to their high speed and their large mass, ions penetrate tissue like an arrow and form a sharply focused bundle of beams with only minimal lateral scattering. Not until they have reached the end of their path, just before they stop, do the ions release the majority of their destructive energy into the tissue. Researchers call this area the Bragg peak, named after its discoverer, William Henry Bragg (1862–1942, English Nobel laureate for physics). The peak is the region in which the radiation reaches its highest value. Afterward, the dose sharply drops down to nearly zero.

With ion beam radiation, higher radiation doses can be administered.
Medical specialists and physicists can control the treatment beam to ensure that the maximum radiation dose hits the tumor precisely. Healthy tissue located next to and behind the tumor remains nearly unaffected. With the aid of the raster scanning technology, many thousand beams (Bragg peaks) can be superimposed, so that tumors of every shape, size and location can be precisely hit by the bundle of beams to within millimeters. Because of the enhanced precision and the capacity to spare healthy tissue of ion beams experts estimate that the dose can be increased by up to 20% with proton radiation and by up to 35% with heavy ion radiation compared to conventional radiation. This would improve the chances of curing the patient.

Heavy ion radiation is biologically more effective.
Cells have powerful mechanisms for repairing radiation damage. The ability of the irradiated tissue to repair itself is significantly lower after heavy ion radiation than after photon radiation with the same dose, because the damage is more substantial. Moreover, heavy ions also damage tumors that are highly resistant to conventional radiation. These are tumors that are very slow growing and those that contain oxygen-poor, poorly vascularized areas.

Ion beams are more accurate and spare healthy tissue

HIT's facilities
are unique

Top class medical technology

Patients with cancer have undergone ion beam therapy at the Heidelberg Ion Beam Therapy Center (HIT) since November 2009. It is extraordinarily precise and highly effective, offering new treatment options for many patients with tumors that have previously been difficult to control with conventional radiation therapy. HIT is a treatment facility of superlatives. An area nearly the size of a soccer field, extending over three stories, two of them underground, with internationally top-class medical technical equipment make HIT a one-of-a-kind treatment center.

Several treatment facilities for proton and heavy ion radiation already exist.
HIT's special equipment offers a number of features that set it apart:

- HIT is Europe's first combined treatment facility using protons and heavy ions for radiation therapy.
- HIT is the first facility to use cooperating robots for automated imaging and ultrahigh-precision patient positioning.
- HIT is the first heavy ion therapy facility with a 360° rotating beam delivery system (gantry)
- HIT is the first ion therapy facility with intensity-controlled raster scanning, the world's most precise radiotherapy method.

The gantry: A gigantic steel construction

> **HIT is Europe's first combined treatment facility where patients can undergo radiation therapy with both protons and various heavy ions.**
This allows comparative clinical studies to be performed. For certain tumor diseases in which conventional radiation therapy is not successful, studies conducted in the coming years will aim to determine which type of radiation therapy yields better cure rates, therapy with protons or heavier ions. Studies will also be conducted to investigate which heavy ions (carbon, oxygen or helium ions) have the best therapeutic effect for the individual tumor diseases. For some tumors, definitive proof is already in place. For others, clinical studies still need to be performed.

> **At HIT, for the first time cooperating robots are used that precisely adjust the treatment table to optimally position the patient in front of the radiation beam.**
The robotic table can be moved in six ways, allowing many different beam entrance angles. With the use of digital x-ray technology, which provides three-dimensional images of the treatment volume and compares them with the treatment plan, the best treatment position can be determined and automatically adjusted.

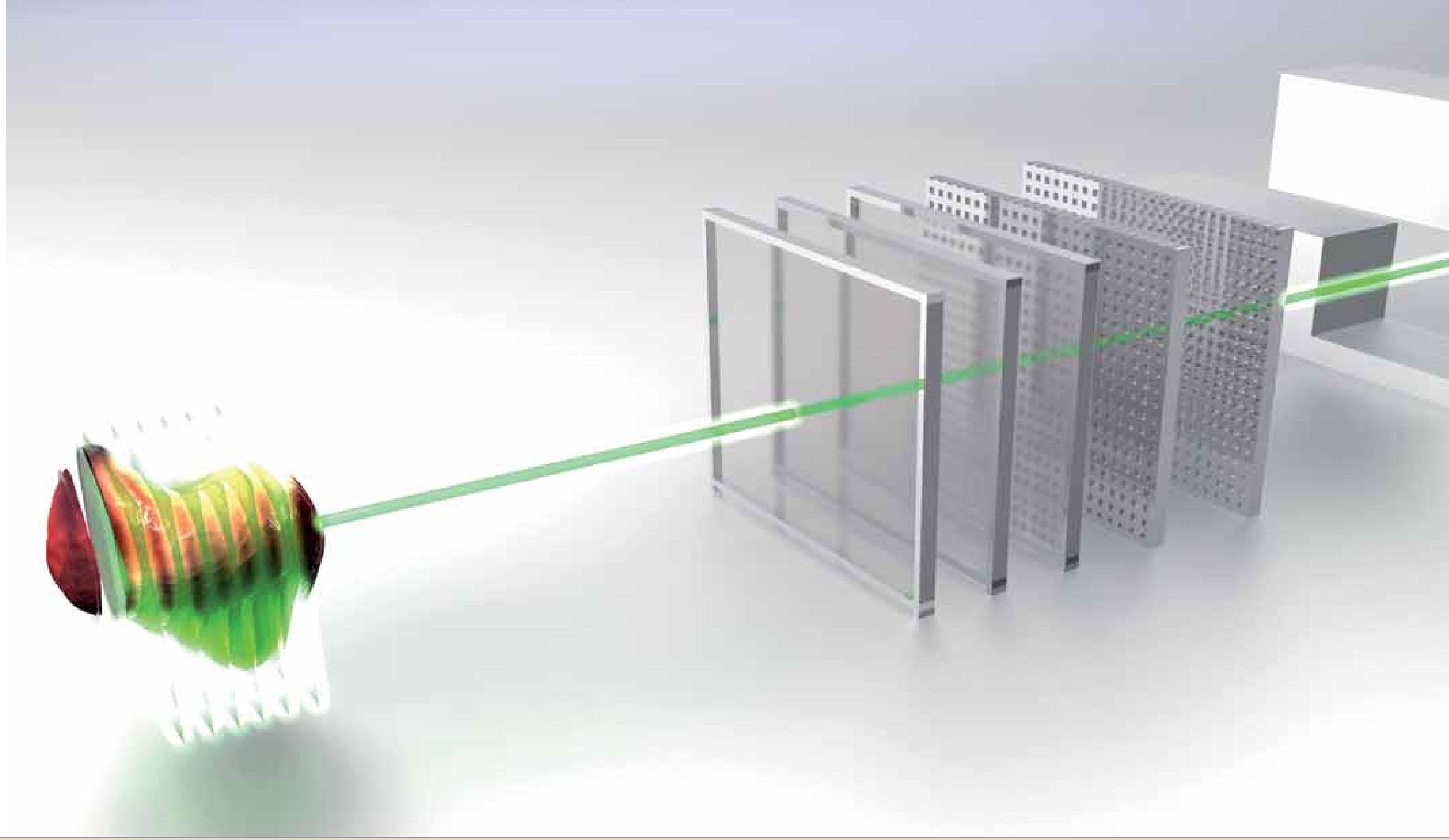
> **HIT is the first heavy ion treatment facility with a 360° rotating beam delivery system (gantry).**
In conventional radiation therapy with photons, mobile radiation sources have already been used very successfully in clinical applications for decades. HIT's gantry allows a tumor to be irradiated with heavy ions from many different angles. In addition, the treatment table can be turned in six ways. By combining these two movements, an infinite number of beam entrance angles can be realized for the beam delivery. The individual pencilbeams are superimposed in the tumor and accumulate into the total dose. The raster scanning method, the most precise irradiation method, was also integrated into the HIT gantry (see page 16). In this way, healthy tissue is optimally spared, even if the tumor has a complicated location in the proximity of highly radiation-sensitive organs such as the intestines or the optic nerve.

The gantry at HIT is a gigantic technical steel construction. It is 25 meters long, 13 meters in diameter, and it weighs 670 tons, of which 600 tons can be rotated with submillimeter precision. The gantry works extremely precisely.
The beam reaches the patients at up to 75% of the speed of light, can penetrate up to 30 centimeters into the tissue and still deviates from the target by no more than one millimeter.

> **HIT is the first ion therapy facility with intensity-controlled raster scanning.**
> This special method allows for the irradiation of tumors of any shape or size and located at any depth in the body with unprecedented precision. “Intensity-controlled” means that cross sections of the tumor are divided into tiny regions, each of which receives an optimized radiation intensity – according to the tumor’s and the adjacent tissue’s sensitivity to radiation.

Charged particles can be guided in arbitrary directions with the aid of magnetic fields. This allows the ion beam to be controlled extremely precisely during irradiation. The Bragg peak position, i.e., the stopping region showing maximum cell killing efficiency, depends on the ion energy. The more the particles are accelerated at HIT, i.e., the faster the ion beam is and, in turn, the more energy it has, the deeper it penetrates the body. 100,000 different beam parameter combinations can be adjusted by the particle accelerator system. These tailored pencilbeams hit the tumor with millimeter precision and irradiate the entire tumor volume. Intensity-modulated treatment has already been used for several years in conventional irradiation with photons. For ion therapy, however, it is completely novel.

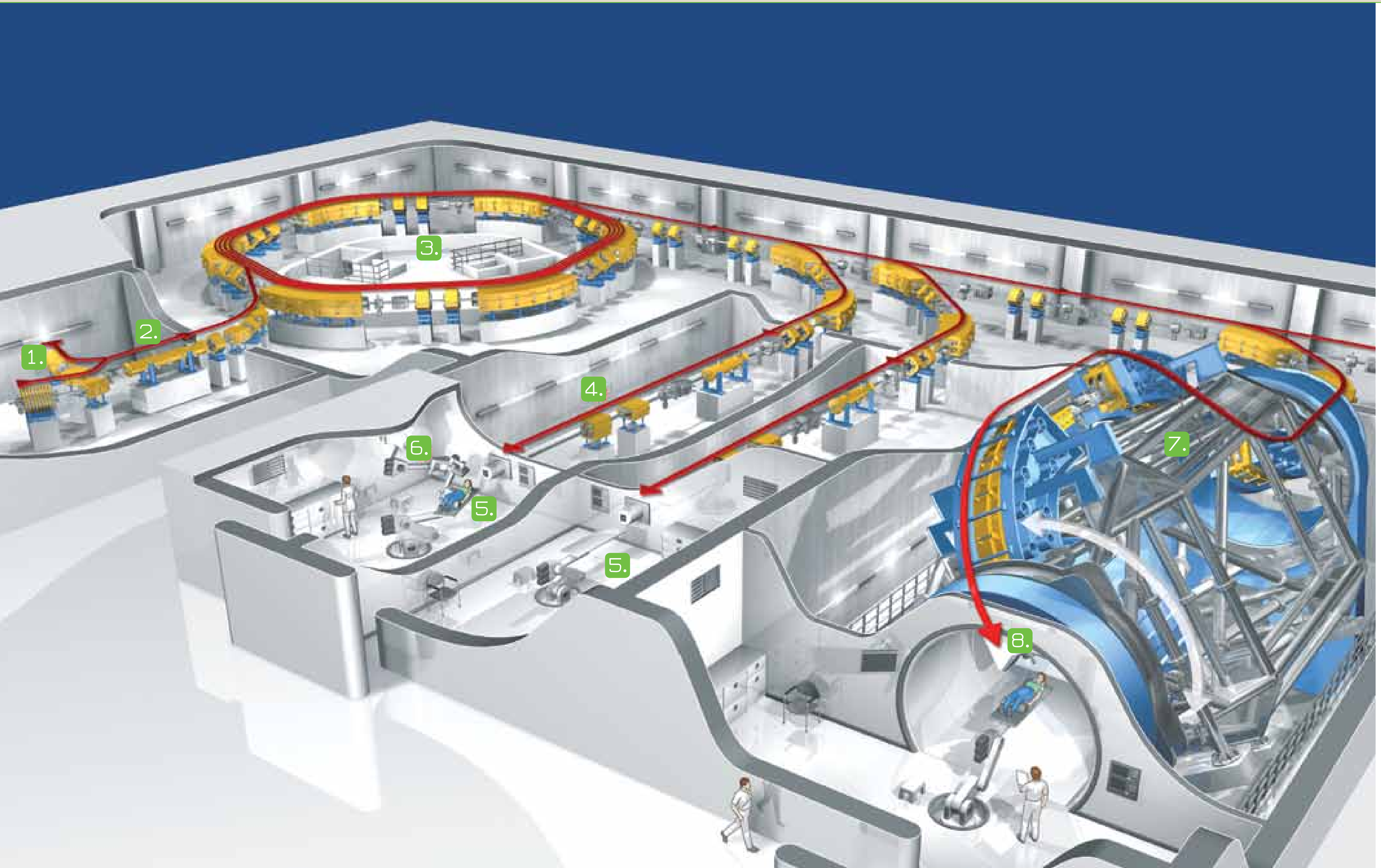
Raster scanning method (right): Computer tomography is used to visualize the exact contours of the tumor in a three-dimensional image, which is then “dissected” into millimeter-thin digital slices with the aid of treatment-planning software. The computer software assigns adjacent pixels to each slice of the tumor in a checkerboard pattern and calculates the required penetration depth and optimal dose for each pixel. The intensity-controlled ion beam scans this grid with extreme precision and remains at each beam position until the calculated dose has been reached. In the presence of sensitive organs directly next to the tumor, this region receives a lower radiation dose. For areas of the tumor that are highly resistant to irradiation, the physicians select a higher dose.



Online therapy monitoring ensures the greatest possible safety
During the treatment, the position, shape and intensity of the ion beam are analyzed up to 100,000 times per second. Five high-resolution particle detectors monitor the entire irradiation field and compare it with the treatment plan. If even the slightest deviation occurs, the irradiation stops within half a millisecond.

The world’s highest precision and safety in ion beam therapy

From the ion beam source to the patient



1. **Ion sources:** This is where beams of positively charged atoms – ions –are generated. To obtain protons, hydrogen gas is used, while carbon dioxide is used for carbon ions.

2. **Two-stage linear accelerator:** Ions are accelerated to up to 12% of the speed of light.

3. **Synchrotron:** Six 60° magnets bend the ion beams into a circular path. Over the course of around one million orbits, the ions are accelerated to up to 75% of the speed of light.

4. **Heading towards the treatment room:** Magnets guide and focus the beam in vacuum tubes.

5. **Treatment room:** The beam enters the treatment room through a window. The patient is positioned on a treatment table that is precisely adjusted by computer-controlled robots.

6. **Position control:** With a digital x-ray system, images are created prior to irradiation and matched with the CT scan used for treatment planning.

7. **The gantry:** The rotating beam delivery system enables the therapy beam to be directed toward the patient at the optimal angle. The gantry weighs 670 tons, of which 600 tons can be rotated with submillimeter precision.

8. **Treatment room in the gantry:** This is where the beam exits the gantry beamline. Two rotating digital x-ray systems are used to optimize the patient position by image-guidance prior to the irradiation.

Patients with rare tumors also receive superior treatment

It is expected that in the long term, ion beam therapy at HIT will help the up to approx. 10% of cancer patients whose tumor growth cannot be controlled with conventional radiation therapy because it is technically impossible to administer a sufficiently high radiation dose. These patients suffer from tumors that

- are located deep inside the body
- are extremely resistant to conventional radiation
- are surrounded by highly radiation-sensitive healthy tissue, such as the optic nerve, the brain stem, the spinal cord or the intestines.

HIT aims to close this treatment gap with its top-class technical equipment and the biologically highly effective ion beam therapy. At full capacity, up to 750 patients per year will be able to undergo radiation therapy.

At present the following types of tumors are irradiated at HIT:

- chordomas and chondrosarcomas at the base of the skull
- salivary gland carcinomas (including adenoid cystic carcinomas)
- chordomas and chondrosarcomas in the pelvic region
- pediatric tumors
- neuro-oncological tumors
- liver cell carcinomas
- inoperable recurrent rectal cancer
- inoperable bone sarcomas
- prostate cancer

For current developments, please check our website at www.hit-heidelberg.com.

Tumor diseases in children

Ion beam therapy is especially suitable for combating certain types of cancer in children. For children it is especially important to prevent long-term adverse treatment effects. Ion beams are best-suited for maximally sparing healthy tissue. This prevents growth and developmental deficits, along with the development of secondary tumors.

Reimbursement of costs by health insurers

An ion beam treatment at HIT is often less expensive than complex surgery and innovative chemotherapies. Reimbursement of costs is arranged via agreements with the health insurers so that their members can benefit from this innovative therapy.

At the Department of Radio-Oncology and Radiotherapy at Heidelberg University Hospital, careful preparation is underway for widespread application of ion beam therapy. In clinical studies, radiation therapists are investigating the efficacy of ion beam radiation compared to conventional radiation therapy. A large proportion of patients is treated as part of these clinical studies today. Further studies are planned for the coming years or are already under review by approval authorities. For current developments, please check our website at www.hit-heidelberg.com.

Coordination Center, Heidelberg

The German Society of Radiation Oncology (DEGRO), Berlin, has assigned the Department of Radiation Oncology and Radiotherapy at Heidelberg University Hospital to act in agreement with the German Cancer Research Center (DKFZ) in Heidelberg as a coordination center for clinical studies and to integrate all centers in Germany that will be interested in proton therapy in the future.

Patients are included in clinical trials

The Heidelberg Ion Beam Therapy Center (HIT) profits from its integration in an outstanding clinical and scientific environment in Heidelberg. It is directly adjoined to the Department of Radiation Oncology and Radiotherapy in the Head Hospital (Kopfklinik) and to the National Center for Tumor Diseases (NCT), as well as to the Children's Hospital. The Department of Internal Medicine, the new Women's Hospital and the new Department of Dermatology are all in close proximity. While the employees of HIT-Betriebs GmbH, mainly physicists and engineers, ensure that the ion beams and the treatment plans are available for treatment, the Department of Radiation Oncology and Radiotherapy provides the medical expertise.

Department of Radiation Oncology and Radiotherapy

At the Department of Radiation Oncology and Radiotherapy, the entire range of state-of-the-art radiation therapy diagnostics and treatment is offered at the highest international level. Each year, more than 4,000 cancer patients are treated at the department, which offers the following types of treatment:

> intraoperative radiation therapy
> intensity-modulated radiation therapy (IMRT) including tomotherapy
> stereotactic radiation therapy
> extracranial stereotactic radiation therapy
> brachytherapy (LDR and HDR)
> total body irradiation
> ion beam therapy
> radiation therapy for children

The clinical studies for the pilot project on ion beam therapy were conducted from 1997 to 2008 at GSI Helmholtz Center for Heavy Ion Research (see pilot project, page 32) under the leadership of Heidelberg University Hospital's Department of Radiation Oncology and Radiotherapy. Both the department and HIT itself also conduct a broad-based research program in the areas of particle accelerator technology, raster scanning, treatment planning, medical physics and radiation biology. This provides the Department of Radiation Oncology and Radiotherapy with unrivaled expertise in the field of ion beam therapy.

HIT is an integral part of the Heidelberg campus

Next door neighbor: The National Center for Tumor Diseases NCT

The National Center for Tumor Diseases (NCT) in Heidelberg, which is directly adjacent to HIT, is a cooperative project between Heidelberg University Hospital, the German Cancer Research Center (DKFZ), the Heidelberg Thorax Hospital and Deutsche Krebshilfe (German Cancer Aid). German Cancer Aid funds the NCT as a Center of Excellence in Oncology.

The NCT's interdisciplinary structure, which combines clinical patient care with the latest cancer research provides patients with a dual benefit: a central point of contact, where they can receive in-depth information and comprehensive care, on the one hand, and the capability to translate new findings and promising approaches gained from basic research into clinical practice more quickly.

Tumor outpatient unit

The central point of contact for patients is the tumor outpatient unit. Here, interdisciplinary consultations are offered in which each patient is jointly examined by all the required specialists and receives a recommendation for treatment. Complicated cases are discussed by an interdisciplinary panel of experts, referred to as a tumor board. Depending on the type of tumor, specialists including surgeons, radiation oncologists and internists cooperate in the consultation.

The result of this conference is a quality-assured treatment plan based on the highest standards. Participation in clinical studies provides patients access to innovative therapies, which may include treatment at HIT, where all studies in the area of heavy ion research conducted throughout Europe are coordinated. NCT is therefore an important platform for translating new research results from the lab to clinical practice.

Patients also profit from a network of counseling services, including psycho-oncological support, self-help groups, nutritional counseling and the Exercise and Cancer program.

HIT collaborates with internationally renowned research centers, most of which were cofounders of HIT or were cooperation partners from the very start.

GSI Helmholtz Center for Heavy Ion Research
The GSI Helmholtz Center for Heavy Ion Research in Darmstadt is one of the internationally top centers for heavy ion research. Over 1,000 scientists from more than 30 nations perform research at its accelerator facility. This center has performed radiobiological research since it was founded, focusing on the radiobiological effect of ions. It has also accumulated extensive expertise in accelerator technology and the development of highly precise irradiation methods. From 1997 to 2008, the SIS heavy ion synchrotron of the GSI Helmholtz Center for Heavy Ion Research was used to operate Europe's only accelerator facility where patients with deep-seated tumors could be treated with ions.

German Cancer Research Center (DKFZ)
The German Cancer Research Center (DKFZ) in Heidelberg, with its focus on radiological diagnostics and treatment, is a center for pioneering research and development in state-of-the-art radiotherapy techniques. The collaboration between Heidelberg University Hospital's Department of Radiation Oncology and Radiotherapy and DKFZ culminated in the founding of the Clinical Research Group Medical Physics and the Clinical Cooperation Unit for Radiation Therapy. A wide range of developments in recent years have been translated into clinical application, quickly and unbureaucratically.

The achievements in Heidelberg to which DKFZ made ground-breaking contributions and which subsequently attained international recognition include:
> three-dimensional radiation treatment planning
> stereotactic radiosurgery
> medical physics-related aspects of therapy with heavy charged particles (carbon ions)
> intensity-modulated radiation therapy (IMRT) and inverse radiation therapy planning, as well as
> techniques for precise patient positioning under the radiation source.

These methods are now established worldwide and have defined new quality standards in oncological radiotherapy.

Helmholtz Center Dresden-Rossendorf (HZDR)
The Helmholtz Center Dresden-Rossendorf (HZDR) performs basic and applied research in the fields of materials research, biomedicine, chemistry, the environment and nuclear, hadron and radiation physics. HZDR has outstanding expertise in the application of positron emission tomography (PET) in biomedicine, and this is also used at HIT. HZDR developed an imaging method for HIT that can visualize the ion beam on its path through the body.

Heidelberg Institute for Radiation Oncology (HIRO)
The Heidelberg Institute for Radiation Oncology (HIRO) serves as a center of concentrated expertise in radiation research for the benefit of patients. It is an internationally renowned alliance of institutions working in all aspects of radiation research in oncology. The alliance includes the German Cancer Research Center (DKFZ), Heidelberg University Hospital and HIT. HIRO and the OncoRay Center for Radiation Research in Oncology in Dresden were named the National Center for Radiation Research in 2010 by Annette Schavan, German Minister for Education and Research. Its structure will allow scientific findings to be implemented to benefit patients even faster in the future. To this end, platforms have been created to rapidly incorporate the results of basic research and accelerate both the conditions for approval and the practical implementation of the new methods. The initial results of this successful collaboration include molecular biological methods that can predict the way tumors will respond to a treatment based on molecular markers in the tissue.

International collaborations
Research collaborations are also in place with partners operating proton and heavy ion facilities in other countries, especially in the United States and Japan.

Origins of radiotherapy in Heidelberg

Founder of radiotherapy in Heidelberg: Vincenz Czerny

The history of radiation therapy in Heidelberg began over 100 years ago. The esteemed Heidelberg surgeon and radiation therapist Vincenz Czerny (1842–1916), whose bust is prominently displayed in the foyer of the Heidelberg Ion Beam Therapy Center (HIT), was one of the first physicians to recognize “that therapy results can be improved by additional radiation and chemotherapy.”

In 1906, he founded the Samariterhaus (Samaritan House) in the Bergheim district of Heidelberg. The Samariterhaus was an “institution for curing and caring for cancer patients.” Czerny established the “Institute for Experimental Cancer Research” there, marking the first time that patient care and research were performed under one roof. In addition to serving as the source of new surgical techniques, the Samariterhaus gave rise to the “three pillars” of cancer treatment in Heidelberg:

> the Department of Radiation Oncology and Radiotherapy at Heidelberg University Hospital, which conducts medical operations at HIT
> the German Cancer Research Center (DKFZ), Heidelberg, and
> the National Center for Tumor Diseases (NCT), Heidelberg.

Today, Heidelberg is renowned as the location of one of the largest and most modern centers for radiation therapy and radiation oncology in the world. Heidelberg is the birthplace of many key developments in oncological radiation therapy that have defined new quality standards for the rest of the world.

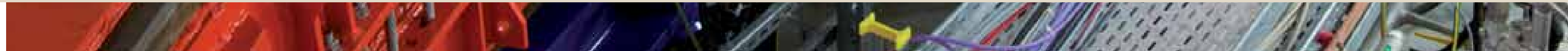
The planning and implementation of the Heidelberg Ion Beam Therapy Center (HIT) was carried out under the general management of the GSI Helmholtz Center for Heavy Ion Research in Darmstadt and the Heidelberg University Hospital's Department of Radiation Oncology and Radiotherapy. The German Cancer Research Center (DKFZ) in Heidelberg and the Helmholtz Center Dresden-Rossendorf (HZDR) also collaborated in the founding of HIT and have developed pioneering methods and key technologies. The preparatory work and expertise of the participating institutions in particle therapy combined to create the ideal preconditions for successfully establishing HIT and involving partners from industry.

Milestones from 1991 to 2012

1991 : The raster scanning technique developed at GSI is tested for the first time.
1992 - 1995 : GSI researchers develop the biologically based treatment planning for heavy ions.
1993 : Four partners initiate planning for a pilot project for ion beam therapy: GSI, the Department of Radiation Oncology and Radiotherapy, DKFZ and HZDR.
1997 : For the first time in Europe, patients undergo radiation treatment with ion beams (carbon) at GSI.
1998 : Submission of a project proposal for setting up a clinical treatment facility for cancer treatment with ion beams.
September 2000 : Presentation of the feasibility study for the Heidelberg heavy ion therapy facility.
November 2001 : Federal Scientific Council votes to fund the project.
May 12, 2004 : The cornerstone of HIT is laid.
June 20, 2005 : Topping out ceremony for the HIT building.
September 1, 2006 : Heidelberg University Hospital takes over the building.
June 2008 : Technical outfitting of HIT completed. Scientific operations launched.
November 2, 2009 : Opening ceremony of HIT.
November 15, 2009 : The first patients undergo ion beam therapy.
November 2011 : HIT celebrates its second anniversary. Approx. 600 patients have been successfully treated. The technology and methodology have undergone further development. For example, the treatment of movable organs has started. The accuracy of the irradiation can be monitored with a PET-CT scan after treatment and corrected if necessary. For its innovative strength, HIT is recognized as a "Selected Landmark 2011" in the "Germany – Land of Ideas" competition.
October 2012 : HIT starts operating the worldwide first heavy ion therapy facility with a 360° rotating beam delivery system (gantry).

1997 to 2008 : The pilot project impressively demonstrates both the clinical efficacy and the technical feasibility of ion therapy: Over 400 patients with chordomas and chondrosarcomas of the skull base and 50 patients with adenoid cyst salivary gland tumors at the Department of Radiation Oncology and Radiotherapy underwent radiation therapy with heavy ions at the GSI Helmholtz Center's particle accelerator. These tumors are nearly impossible to treat with conventional radiation. The majority of these patients were cured after undergoing heavy ion therapy.

Development of HIT



HIT's architecture: Technology and aesthetics in harmony

Offices and conference rooms in the glass structure

The Heidelberg Ion Beam Therapy Center (HIT) features top-class medical technology surrounded by impressive architecture. Despite its impressive spatial volume, HIT, built from the ground up between the Head Hospital (Kopfklinik) and the Children's Hospital, is integrated into the natural landscape in an unassuming and harmonious manner. HIT covers an area of 5,027 square meters, nearly the size of a soccer field. It has three stories, two of them underground, and is divided into three building sections that reflect their respective uses: a glass structure, a copper block and a green plateau.

The glass structure, which rises one story above ground level, houses the offices of the 70 physicians, assistants and nursing personnel, along with those of the physicists, engineers and technicians. Directly connected to the glass structure, the "copper block," with its striking copper roof, rises from the ground, constituting the highest part of the radiotherapy tract. This room spans all three stories, because it hosts the heavy ion gantry. Weighing 670 tons and 25 meters long and 13 meters in diameter, the gantry is the world's first 360° rotatable ion beam delivery system. The other rooms in the radiotherapy area are located underground and have been covered with a layer of soil up to seven meters high in the form of a grassy hill. Referred to as the "green plateau," it is seamlessly nestled in the existing landscape. This is where the irradiation technology is located, with the ion source, linear accelerator and particle accelerator (synchrotron). Next to this are the three radiation rooms, the radiation room of the gantry and two horizontal irradiation sites with fixed beam. To ensure protection from radiation, the entire radiotherapy area is surrounded by concrete walls and ceilings up to 2.5 meters thick. A connecting passage links HIT with the Head Hospital, where the Department of Radiation Oncology and Radiotherapy is located, the National Center for Tumor Diseases (NCT) and the Children's Hospital.

Operator:
Heidelberg University Hospital

Scientific and Medical Director:
Prof. Jürgen Debus

Scientific and Technical Director:
Prof. Thomas Haberer

Building size/architecture:
5,027 square meters (nearly the size of a soccer field); three stories, two of them underground. Three sections: above-ground glass structure with the staff offices; underground radiotherapy area; copper block with the heavy ion gantry that extends through all three stories (the gantry weighs 670 tons and is 13 meters in diameter)

Construction start/opening:
May 2004/November 2009

Total costs:
€119 million (50% funded by Heidelberg University Hospital and 50% by the German government)

Staff:
The team of around 70 employees comprises physicians, nursing staff, medical-technical radiology assistants, physicists, engineers and technicians.

Capacity:
At full capacity, 750 patients per year can undergo radiation therapy at HIT.

Medical innovations:

> HIT is Europe's first combined treatment facility using protons and heavy ions for radiation therapy.
> HIT is the first facility to use cooperating robots for automated imaging and ultrahigh-precision patient positioning.
> HIT is the first heavy ion therapy facility with a 360° rotating ion beam delivery system (gantry).
> HIT is the first ion therapy facility with intensity-controlled raster scanning, the world's most precise radiotherapy method.

Radiation treatment rooms:
Three radiotherapy rooms for patient treatment with raster scanning and one irradiation facility for methodological tests and developments in the field of ion beam therapy. Two treatment rooms are equipped with a fixed horizontal beam, while the third room has a 360° rotational ion beam delivery system source (gantry) that moves around the patient.

The treatment tables are robot-controlled and can be moved in six ways to select the ideal beam entrance angle of the ion beam. Ceiling-mounted robots guide digital x-ray systems with which the position of the patient is determined prior to irradiation and can be fine-tuned automatically using the treatment couch.

Radiation used:
Ion beam radiation, also referred to as particle radiation. Protons are positively charged nuclei of hydrogen atoms. Heavy ions are positively charged nuclei of atoms with a larger mass (at HIT, carbon, oxygen and helium ions are used). Ion radiation guarantees the highest possible precision. In addition, heavy ions have greater clinical efficacy than conventional irradiation with photons of the same dose.

Operating times:
HIT is in operation 24 hours a day. The beam generated is used around the clock, either for therapeutic or for research purposes. It is used for patient radiation six days a week for an estimated 12 to 14 hours a day.

Energy consumption:
The accelerators are in use 24 hours a day and are operated in three shifts. HIT consumes a maximum of three megawatts, equivalent to the energy required for a small town with a population of approx. 3,000.

HIT's vital statistics

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